Effects of Increasing Dietary Wheat Middlings and Dried Distillers Grains with Solubles on Nursery Pig Growth Performance

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Summary

A total of 180 pigs (PIC 327 × 1050, initially 26.9 lb BW) were used in a 21-d trial to evaluate the effects of increasing dietary wheat middlings (midds) and dried distillers grains with solubles (DDGS) on nursery pig growth performance. Pens of pigs were balanced by initial BW and were randomly allotted to 1 of 6 dietary treatments with 5 replications per treatment. The 6 corn-soybean meal–based diets were arranged in a 2 × 3 factorial with main effects of DDGS (0 or 20%) and wheat midds (0, 10, or 20%). Diets were not balanced for energy, so as wheat midds increased, dietary energy concentration decreased.

Overall (d 0 to 21), no DDGS × wheat midds interactions ($P > 0.12$) were observed. Pigs fed increasing wheat midds had decreased (linear, $P < 0.02$) ADG and poorer (linear, $P < 0.01$) F/G. Feed cost/pig and revenue/pig both decreased (linear, $P < 0.02$) with increasing wheat midds. Feeding pigs a diet containing 20% DDGS did not affect growth performance ($P > 0.59$) but decreased ($P < 0.005$) feed cost/pig. These data suggest that adding DDGS to diets containing wheat midds can be used to decrease feed costs when formulating nursery pig diets; however, increasing wheat midds decreased growth rate and economic return in this experiment.

Key words: DDGS, nursery pig, wheat middlings

Introduction

Wheat middlings and corn DDGS are common high-fiber (wheat midds = <9.5%; DDGS = 7.3%) by-products of the wheat milling and ethanol industries, respectively. With corn increasing in price, these two ingredients have become common alternatives to help lower feed costs. Although traditional DDGS have an energy value similar to corn, midds have a lower energy concentration (ME = 1,372 kcal/lb; NRC, 1998[2]).

In a recent trial, nursery pigs fed over 15% midds had decreased ADG and ADFI but relatively unchanged F/G (De Jong et al., 2011[3]). In addition, research has shown that DDGS can be fed in nursery diets without altering performance. Although research has been conducted that combines dietary midds and DDGS in diets for growing and finishing pigs, no data are available on their potential interactive effects in nursery diets. The objective of this study was to determine the effects of increasing dietary wheat

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[3] De Jong et al., Swine Day 2011, Report of Progress 1056, pp. 114–117.

midds (10 and 20%) in combination with DDGS (20%) on growth performance of nursery pigs from 25 to 50 lb.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the K-State Swine Teaching and Research Center in Manhattan, KS.

A total of 180 pigs (PIC 327 × 1050, initially 26.9 lb BW and 39 d of age) were used in a 21-d growth trial. Pigs were allotted to pens by initial BW so pen initial average BW was similar among pens; pens were then assigned to treatments in a completely randomized design with 6 pigs per pen and 5 replications per treatment. All pigs were fed a common diet before being allotted to treatments. The 6 treatment diets were arranged in a 2 × 3 factorial with main effects of wheat midds (0, 10, and 20%) with or without 20% DDGS (Table 1). For diet formulation, the ME value of DDGS was similar to that of corn (1,551 kcal/kg), and the ME value of wheat midds was 1,372 kcal/lb (NRC, 1998). Diets were not balanced for energy; thus, increasing wheat midds decreased ME. All diets were formulated to a constant standardized ileal digestible (SID) lysine level to ensure changes in performance were due to dietary energy differences rather than differences in amino acid concentrations. All diets were fed in meal form and were prepared at the K-State Animal Science Feed Mill.

Each pen contained a 4-hole, dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pens had wire-mesh floors and allowed approximately 3 ft^2/pig. Pig weight and feed disappearance were measured on d 0, 7, 14, and 21 of the trial to determine ADG, ADFI, and F/G.

Samples of wheat midds, DDGS, and complete diets were collected and submitted to Ward Laboratories, Inc. (Kearney, NE) for analysis of DM, CP, ADF, NDF, crude fiber, fat, ash, Ca, and P (Tables 2 and 3). In addition, bulk density and particle size of the wheat midds, DDGS, and complete diets was determined. Caloric efficiency was determined on both an ME and NE basis using NE values obtained from INRA (2004[4]). Efficiencies were calculated by multiplying total feed intake × energy in the diet (kcal/lb) and dividing by total gain. Lastly, feed cost/pig, feed cost/lb gain, revenue/pig, and income over feed cost (IOFC) were also calculated. Diet costs were determined with the following ingredient prices: corn, $8.00/bu; soybean meal, $480/ton; midds, $240/ton; DDGS, $280/ton. Feed cost/pig was determined by total feed intake × cost/lb feed. Feed cost/lb gain was calculated using F/G × feed cost/lb. Revenue/pig was determined by total gain × $0.65/lb live gain, and IOFC was calculated using revenue/pig – feed cost/pig.

Data were analyzed as a completely randomized design using the PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC), with pen as the experimental unit. Initial weight was used as a covariate for all statistical analysis. Data were analyzed for wheat midds × DDGS interactions as well as wheat midds and DDGS main effects.

[4] INRA (Institut National de la Recherche Agronomique). 2004. Tables of composition and nutritional value of feed materials, Sauvant, D., J-M. Perez and G. Tran, Eds. Wageningen Academic Publishers, The Netherlands and INRA, Paris, France.

Polynomial contrasts were used to determine linear and quadratic effects of increasing wheat midds. Statistics were considered significant at $P < 0.05$ and were considered tendencies at $P > 0.05$ but < 0.10.

Results and Discussion

The chemical analysis of the wheat midds and DDGS (Table 2) revealed that most nutrients were similar to formulated values. Crude protein levels were slightly higher for both ingredients than formulated values. Crude fiber levels were lower for midds but slightly higher for DDGS than calculated values, and the P levels were slightly higher than the formulated values for both ingredients. As expected, analysis of the dietary treatments showed increased fiber component levels with the addition of increasing wheat midds or DDGS to the diet. Diet bulk density decreased with increasing wheat midds as well as when DDGS were added to the diet.

Overall (d 0 to 21), no wheat midds × DDGS interactions ($P > 0.12$) were observed for any growth performance or economic measurements (Table 4). Increasing wheat midds decreased (linear, $P < 0.02$) ADG and final BW. Increasing wheat midds resulted in poorer (linear; $P < 0.01$) F/G with no change in ADFI. Feed cost/pig and total revenue/pig also decreased (linear, $P < 0.02$) with increasing wheat midds. No differences in growth performance criteria were observed when 20% DDGS was fed ($P > 0.59$), but adding DDGS to the diet decreased ($P < 0.005$) feed cost/pig. When feed efficiency was evaluated on an ME or NE kcal per unit of gain basis no differences were observed in energetic efficiency.

The poorer feed efficiency of pigs as more wheat midds were added was not completely unexpected, because diets were not balanced for energy. Pigs did not compensate by consuming more feed, so ADG was reduced. In the current trial, this effect occurred when 10% midds were included, in contrast to our previous study, when it did not occur until 15% midds was fed (De Jong et al., 2011[3]).

An important finding of the research was that no interactive effects occurred when feeding 20% DDGS in combination with up to 20% midds for nursery pigs; thus, these two ingredients can be used together without interactive effects to help reduce feed costs.

Table 1. Diet composition (as-fed basis)[1]

Item	DDGS, %:[2]	0			20		
	Wheat middlings, %:	0	10	20	0	10	20
Ingredient, %							
Corn		63.74	56.22	48.71	47.57	40.05	32.54
Soybean meal (46.5% CP)		32.79	30.33	27.87	29.27	26.81	24.34
DDGS		---	---	---	20.00	20.00	20.00
Wheat middlings		---	10.00	20.00	---	10.00	20.00
Monocalcium phosphate (21% P)		1.05	0.90	0.75	0.60	0.45	0.30
Limestone		0.95	1.03	1.10	1.20	1.28	1.35
Salt		0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix		0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix		0.15	0.15	0.15	0.15	0.15	0.15
L-lysine HCl		0.33	0.37	0.41	0.37	0.41	0.45
DL-methionine		0.135	0.135	0.135	0.045	0.045	0.045
L-threonine		0.125	0.140	0.155	0.070	0.085	0.100
Phytase[3]		0.125	0.125	0.125	0.125	0.125	0.125
Total		100	100	100	100	100	100
Calculated analysis							
Standard ileal digestible (SID) amino acids, %							
Lysine		1.28	1.28	1.28	1.28	1.28	1.28
Isoleucine:lysine		61	60	59	65	64	62
Leucine:lysine		129	125	121	150	146	142
Methionine:lysine		34	33	33	30	30	30
Met & Cys:lysine		58	58	58	58	58	58
Threonine:lysine		63	63	63	63	63	63
Tryptophan:lysine		17.5	17.5	17.5	17.5	17.5	17.5
Valine:lysine		68	67	67	74	73	73
Total lysine, %		1.42	1.41	1.40	1.45	1.45	1.44
ME, kcal/lb[4]		1,504	1,487	1,471	1,507	1,490	1,474
NE, kcal/lb[5]		1,073	1,045	1,017	1,085	1,057	1,029
SID lysine:ME, g/Mcal		3.86	3.90	3.95	3.85	3.90	3.94
CP, %		21.2	21.0	20.9	23.5	23.4	23.2
CF, %		2.7	3.1	3.6	2.2	2.6	3.1
NDF, %		4.1	5.3	6.5	6.4	7.6	8.8
ADF, %		1.6	1.9	2.3	2.8	3.1	3.5
Ca, %		0.69	0.69	0.69	0.69	0.69	0.69
P, %		0.63	0.65	0.67	0.60	0.63	0.65
Available P, %		0.30	0.30	0.30	0.30	0.30	0.30

[1] Treatment diets fed for 21 d.
[2] Dried distillers grains with solubles.
[3] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 340.5 phytase units (FTU)/lb, with a release of 0.12% available P.
[4] NRC. 1998. Nutrient Requirements of Swine, 10th ed. Natl. Acad. Press, Washington DC.
[5] INRA (Institut National de la Recherche Agronomique). 2004. Tables of composition and nutritional value of feed materials, Sauvant, D., J-M. Perez and G. Tran, Eds. Wageningen Academic Publishers, The Netherlands and INRA, Paris, France.

Table 2. Chemical analysis of wheat middlings and dried distillers grains with solubles (DDGS; as-fed basis)[1]

Item	Wheat middlings	DDGS
DM, %	90.45	92.16
CP, %	16.50 (15.90)	29.50 (27.20)
ADF, %	10.30	10.20
NDF, %	32.40	29.50
Crude fiber, %	8.30 (7.00)	7.10 (7.30)
Ca, %	0.10 (0.12)	0.07 (0.03)
P, %	1.07 (0.93)	0.88 (0.71)
Fat, %	4.50	9.50
Ash, %	5.14	4.81
Bulk density lb/bu	22.99	37.49

[1] Values in parentheses indicate those used in diet formulation; values in parentheses from NRC, 1998. Nutrient Requirements of Swine, 10th ed. Natl. Acad. Press, Washington DC.

Table 3. Chemical analysis of diets containing wheat middlings and dried distillers grains with solubles (DDGS; as-fed basis)[1]

DDGS, %:	0			20		
Item Midds, %:	0	10	20	0	10	20
DM, %	91.08	90.94	91.19	91.55	91.83	91.81
CP, %	22.30	21.60	21.20	23.90	23.80	22.30
ADF, %	2.30	3.10	3.70	4.40	5.50	5.50
NDF, %	9.20	12.10	14.90	11.40	14.60	14.70
Crude fiber, %	2.40	2.90	3.30	3.10	3.80	4.30
Ca, %	0.85	0.91	0.83	0.80	0.87	0.73
P, %	0.63	0.66	0.68	0.62	0.68	0.68
Fat, %	2.60	2.90	3.00	3.90	4.20	4.30
Ash, %	5.11	5.44	5.46	5.18	5.58	5.18
Bulk density, lb/bu	53.38	48.70	46.39	48.75	44.93	42.37

[1] A composite sample consisting of 6 subsamples was used for analysis.

Table 4. The effects of wheat middlings and dried distillers grains with solubles (DDGS) on nursery pig growth performance[1]

Item	DDGS, %:	0			20				Probability, $P<$	
	Midds, %:	0	10	20	0	10	20	SEM[2,3]	Linear	Quadratic
d 0 to 21										
ADG, lb		1.31	1.24	1.23	1.28	1.28	1.23	0.029	0.02	0.98
ADFI, lb		2.09	2.04	2.04	2.04	2.10	2.10	0.036	0.56	0.78
F/G		1.59	1.64	1.66	1.60	1.65	1.71	0.032	0.01	0.82
Caloric efficiency[4]										
ME		2,397	2,440	2,442	2,406	2,453	2,519	46.76	0.15	0.81
NE		1,710	1,715	1,688	1,733	1,740	1,759	32.69	0.84	0.77
BW, lb										
d 0		26.7	26.8	26.7	26.7	26.7	27.7	0.636	0.59	0.79
d 21		54.25	53.0	52.6	53.6	53.6	53.6	0.595	0.02	0.98

[1] A total of 180 pigs (PIC 327 × 1050, initially 26.9 lb BW and 39 d of age) were used in a 21-d growth trial with 6 pigs per pen and 5 pens per treatment.
[2] No wheat midds × DDGS interactions were observed, $P > 0.12$.
[3] No DDGS effects, $P > 0.41$.
[4] Caloric efficiency is expressed as kcal/lb gain.

Table 5. Economics of wheat middlings and dried distillers grains with solubles (DDGS) in nursery pig diets[1]

Item	DDGS, %:	0			20				Probability, $P<$	
	Midds, %:	0	10	20	0	10	20	SEM[2,3]	Linear	Quadratic
d 0 to 21										
Feed cost/pig, $		8.38	7.95	7.88	7.89	7.87	7.39	0.141	0.001	0.86
Feed cost/lb gain, $[4]		0.30	0.30	0.30	0.29	0.29	0.29	0.006	0.88	0.84
Total revenue/pig, $[5,6]		17.94	17.09	17.18	17.51	17.46	16.46	0.387	0.02	0.98
IOFC[7]		9.56	9.14	9.30	9.61	9.60	9.07	0.302	0.18	0.96

[1] A total of 180 pigs (PIC 327 × 1050, initially 26.9 lb BW and 39 d of age) were used in a 21-d growth trial with 6 pigs per pen and 5 pens per treatment.
[2] No midds × DDGS interactions, $P > 0.12$.
[3] DDGS effects, $P < 0.005$ for feed cost/pig; no other significant DDGS effects.
[4] Feed cost/lb gain = feed cost/lb × F/G, assumed grinding = $5/ton; mixing = $3/ton; delivery and handling = $7/ton.
[5] One pound of live gain was considered to be worth $0.65.
[6] Total revenue/pig = total gain/pig × $0.65.
[7] Income over feed cost = total revenue/pig – feed cost/pig.